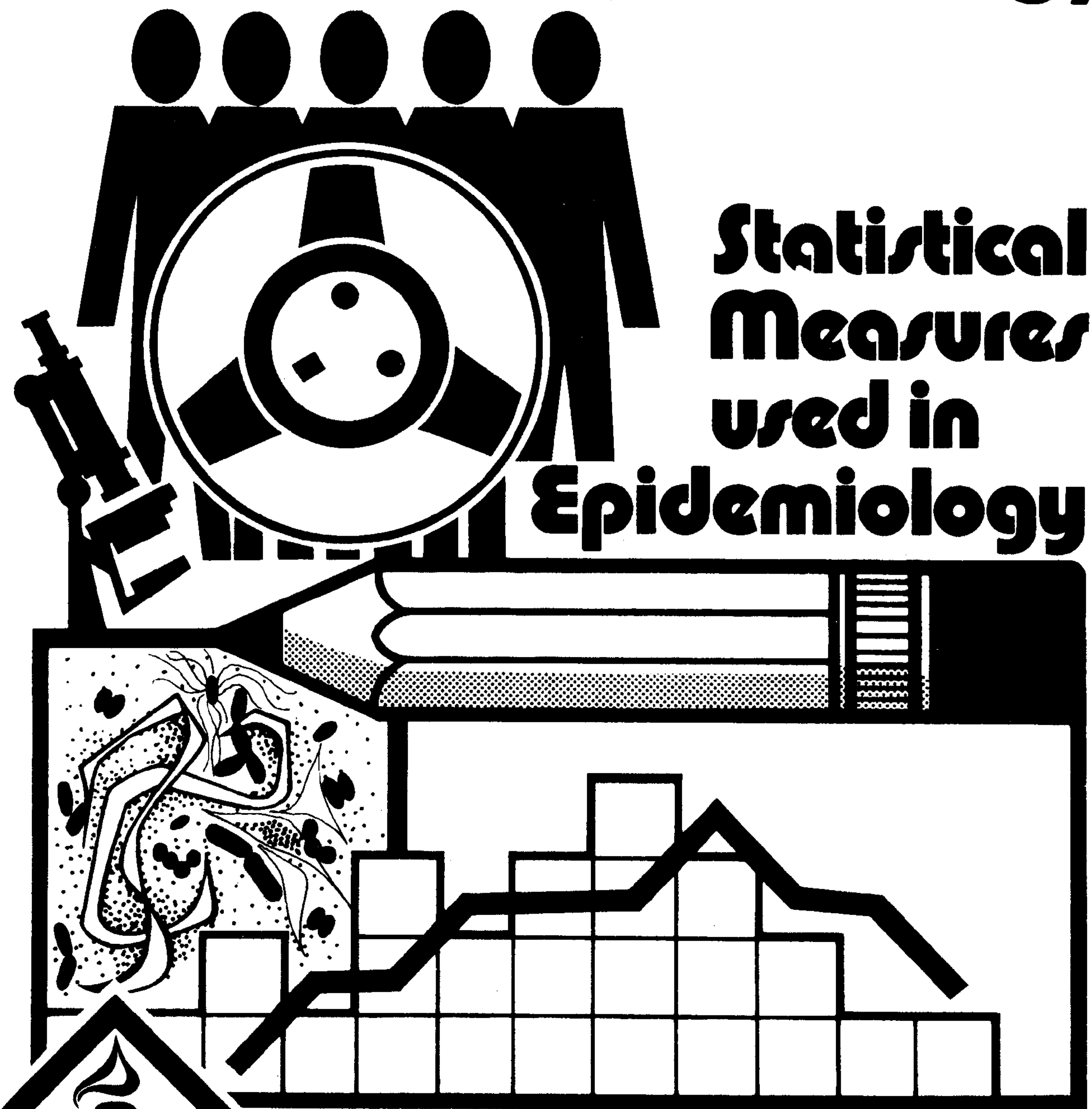
CDC

MANUAL 3

SELF-STUDY COURSE 3030-G

Principles of Epidemiology



Statistical Measures used in Epidemiology

SELF-STUDY

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10/88:4R

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PRINCIPLES OF EPIDEMIOLOGY

Self-Study Course 3030-G

STATISTICAL MEASURES USED IN EPIDEMIOLOGY: Rates, Ratios, and Proportions

INTRODUCTION

This lesson is on the five following calculations: (a) incidence rates; (b) attack rates; (c) proportional distributions; (d) mortality rates; and (e) ratios.

The objectives of this lesson are to enable the student to:

(a) define an incidence rate, an attack rate, a proportional distribution, a mortality rate, and a ratio;
(b) specify which of the five calculations is most appropriate for analyzing a given situation;
(c) correctly identify the numerator and denominator for a given calculation in a particular set of data;
(d) correctly perform the appropriate calculation; and,
(e) interpret the resulting figures.

Many other calculations are also useful and necessary for various purposes in epidemiology, but they will not be part of this lesson. These five were selected because they are the ones most frequently used to measure and describe the occurrence of morbidity and mortality. Morbidity is usually measured with incidence rates and attack rates; and mortality with mortality rates. Proportions and ratios are applied to both morbidity and mortality.

Knowing just the numbers of cases or deaths is not sufficient to identify the risk of infection or death among members of various populations; rates must be used. Causally associated factors resulting in morbidity and mortality are seldom randomly distributed among all populations, and a major task in epidemiology is to identify the specific population groups at highest risk of these events. This process essentially consists of relating the cases or deaths to subpopulations characterized on the basis of such variables as age, sex, race, occupation, socioeconomic status, and geographic location. The calculation of rates and ratios relevant to such variables is important in identifying factors present within these populations or their environments which have a causal relationship. Such information is important to the identification of practical and efficient control measures.

DEFINITIONS AND FORMULAS

Before proceeding with the examples of the use of the selected statistical measures, we will first briefly review the definition and formula for each and draw distinctions between them.

The formula for all five of the calculations which we will be dealing with here has the same basic form:

Rate (or ratio or proportion) = $\frac{x}{y} \times k$, which can be read x times k, divided by y; or x divided by y, multiplied by k.

The differences among the calculations lie in the definitions of x and y and the values assigned to k.

Rates measure the probability of occurrence in a population of some particular event such as cases or deaths due to infectious diseases. In the instance of rates, the above formula gives the answer to this question: If x number of cases of disease, or deaths, occurred in a population of size y, how many would be expected to occur in a population of size k? This same question can be stated as:

$\frac{x}{y} = \frac{\text{Rate (or expected number)}}{k}$, which is read x divided by y equals the rate, or expected number, divided by k.

Cross-multiplying yields:

$$(\text{Rate}) \times y = x \times k$$

Dividing both sides of the equation by y yields:

$\text{Rate} = \frac{x \times k}{y}$ which is the same as: $\text{Rate} = \frac{x}{y} \times k$

Knowing the rate (i.e., the frequency of occurrence of the event represented by x in a population of "standard" size), the relative frequency of occurrence of the event being studied can be legitimately compared among various populations, and factors contributing to the observed differences in occurrence can be sought.

Following are the definitions used for each calculation. These definitions are not general ones, but are specific to their use in the practice of epidemiology.

INCIDENCE RATE

Definition: An incidence rate is a measure of the frequency of occurrence of new cases of a disease within a defined population during a specified period of time.

The formula used in calculating incidence rates is:

$$\text{Rate} = \frac{x}{y} \times k$$

Where: x = the number of people in a defined population (defined in terms of time, place and person) who become ill from a specified cause during a specified interval of time.

y = the number of people in the defined population during the same specified interval within which the cases occurred. Usually the size of the population at the middle of the time interval is taken as the size of the defined population.

k = an assigned value of 100,000, usually. However, values of 100, 1,000, 10,000, or even 1,000,000 are often assigned. The selection of a value for k is usually made so that the smallest rate calculated in a series has at least one digit to the left of the decimal point (i.e., to yield a small whole number: 4.2/100, not 0.42/1,000; 9.6/100,000, not 0.96/1,000,000.)

Any of these values can be used, but whoever is presenting the data must make clear to other readers which k value is being used, either by writing it at the head of columns in which rates are presented or by writing it beside the figure calculated: 5/100; 7/1,000; 1.2/10,000; 4.3/100,000.

Comments:

- In epidemiologic practice, incidence rates are the most commonly used way of measuring the extent or frequency with which infectious disease is experienced by population groups. A population that has a higher incidence rate of an illness than does a second population is said to be at a higher risk of experiencing that event than is the second group. The first population could also be termed a high risk group (relative to the second population).

  In the analysis of disease surveillance data, the defined population referred to is most frequently the population of one or more census tracts, socioeconomic areas, cities, counties, or states. However, it may be virtually any population: that of hospitals, schools, and military groups; populations having particular age, sex, or occupational characteristics; or people having any specified characteristic by which they can be grouped for purposes of epidemiologic study. The practical limits in the selection of populations for data analysis are the lack of detail in the reported data (the x) and the lack of knowledge of the number of people in many of the populations (the y) which can be defined, especially in the intercensal years. Ideally, the denominator, y, should only include persons who are susceptible (at risk of disease). The difficulty with this is that in the absence of a special survey, the proportion of a population which is not susceptible to a particular disease is usually not known.

- The specified interval of time most commonly used is the calendar year, but any interval may be used as long as the limits of the interval are identified.

- Incidence rates are often confused with prevalence rates. They are similar but the difference is important and must be kept in mind when performing the respective calculation. The difference is this: in a prevalence rate, the numerator, x, includes not only the number of people who became ill (new cases) during the specified interval but also those who became ill prior to the specified interval and remained ill (old cases) during some portion of that interval. In other words the numerator of a prevalence rate includes all persons ill from a specified cause during a specified interval (or at a specified point in time) - regardless of when the illness began. The numerator of an incidence rate consists only of persons whose illness began during the specified interval.

Example: During 1977, a total of 412 cases of a particular disease were reported in a city having a population of 212,000. What is the incidence rate per 100,000 population in that city during that year?

$$\text{Incidence rate} = \frac{412}{212{,}000} \times 100{,}000 = \underline{194.3/100{,}000}.$$

It was also known that 19 of these cases were females under ten years of age. At that time the female population under 10 years of age was 19,080. What was the age-sex specific incidence rate during that year in that city?

$$\text{Incidence rate} = \frac{19}{19{,}080} \times 100{,}000 = \underline{99.6/100{,}000}.$$

ATTACK RATE

Definition: An attack rate is an incidence rate, usually expressed as a percent and applied to narrowly defined populations observed for limited periods of time, as in an epidemic.

The formula for an attack rate is:

$$\text{Rate} = \frac{x}{y} \times k$$

Where: x = same as incidence rate

y = same as incidence rate

k = almost always 100, although it may be 1,000. When k is equal to 100, the attack rate may be expressed either as the number of cases per 100 population or as a percent (%).

Example: In an outbreak involving 26 cases of disease "x," seven of the cases were found to be female and 19 male. In the group in which the outbreak occurred there were a total of 9 females and 87 males. What is the attack rate among the members of each sex and among the group as a whole?

Sex	Number of cases	Number of persons
Male Female	19 7	87 9
TOTAL	26	96

Calculations:

Male attack rate = $\frac{19}{87}$ X 100 = 1900 ÷ 87 = <u>21.8</u>

Female attack rate = $\frac{7}{9}$ X 100 = 700 ÷ 9 = <u>77.8</u>

Over-all attack rate = $\frac{26}{96}$ X 100 = 2600 ÷ 96 = <u>27.1</u>

Note that the overall attack rate is obtained by dividing the total number of cases by the total number of persons, <u>NOT</u> by adding together the attack rates for each of the sexes.

PROPORTIONAL DISTRIBUTION

Definition: A proportional distribution is the percent (i.e., proportion) of the total number of events in a data set which occurred in each of the categories (or subgroups) of that set.

The formula used in calculating a proportional distribution is:

$$\text{Percent} = \frac{x}{y} \times k$$

Where:

x = the number of events or people, etc., that occurred in a particular category or subgroup of a larger group.

y = the total number of events, people, etc, that occurred in all categories of the particular data set.

k = is always equal to 100.

Comments:

- A proportional distribution is commonly used in situations where it is not possible to calculate an incidence rate; however, it is <u>not a rate</u> and therefore it cannot be interpreted as an estimate of the risk of exposure or infection UNLESS the number of, events, persons, etc., to whom the event COULD HAVE occurred is the same in each of the subgroups. This usually is not the case.

- Since x and y are defined the way they are, the various percents in a given data set can and should be added up for all the categories in that set, and the total should be 100%. Rates <u>cannot</u> be similarly totaled.

- The interpretation of a proportional distribution is: of the total frequency with which a particular type of event occurred in a particular population, it occurred the stated percent of the time in the various constituent subgroups.

Example: In an outbreak involving 26 cases of disease x, 7 were female and 19 were male. The total number of persons of each sex that were in the affected group is unknown. What is the proportional distribution of the cases by sex?

Sex	Number of cases	Proportional (or percent) distribution
Male	19	73.1
Female	7	26.9
TOTAL	26	100.0

$$\% \text{ Male} = \frac{19}{26} \times 100 = \underline{73.1}$$

$$\% \text{ Female} = \frac{7}{26} \times 100 = \underline{26.9}$$

MORTALITY RATE

Definition: A mortality rate is a measure of the frequency of occurrence of deaths within a defined population during a specified interval of time.

The formula for a mortality rate is:

$$\text{Rate} = \frac{x}{y} \times k$$

Where: x = the number of people in a defined population, during a specified interval of time, who (1) die from <u>any</u> cause (crude rate); or (2) die from a specified cause (cause-specific rate).

y = same as incidence rate: the number of people in the defined population during the specified interval of time.

k = usually an assigned value of 1,000 when x includes deaths from all causes. An assigned value of 100,000 is used when x represents deaths from a specified cause.

Comments: - A mortality rate differs from an incidence rate only in that a mortality rate measures the frequency of <u>deaths</u> and a morbidity rate measures the frequency of <u>illness</u>.

- The specified populations and intervals most commonly used in calculating mortality rates are generally the same as for incidence rates.

- Just as mortality rates can be made cause-specific by limiting x to persons who die from a specified cause, they can be made age-specific by limiting y to the population of a particular age-group and x to persons in that age-group who die. Mortality rates can be made sex-specific by limiting y to the members of a specified sex and x to members of that group who die.

Example: In a city of 212,000 population a total of 1,900 persons died during the year, four from disease y. What was the crude death rate per 1,000? What was the cause-specific death rate per 100,000?

$$\text{Crude death rate} = \frac{1{,}900}{212{,}000} \times 1{,}000$$

$$= \underline{9.0 \text{ deaths per } 1{,}000 \text{ population}}$$

$$\text{Cause-specific death rate} = \frac{4}{212{,}000} \times 100{,}000$$

$$= \underline{1.9 \text{ deaths per } 100{,}000 \text{ population}}$$

RATIO

Definition: A ratio is an expression of the relative frequency of occurrence of some event compared to some other event (e.g., the number of immune 6th graders compared to the number of nonimmune 6th graders in a particular school).

The formula for a ratio is:

$$\text{Ratio} = \frac{x}{y} = x\ k$$

Where: x = the number of events, persons, etc., having one or more specified attributes.

y = the number of events, persons, etc., having one or more specified attributes, but which differ from the attributes of the members of x in some way.

k = 1

Since k = 1, the formula for a ratio can be reduced to:

$$\text{Ratio} = \frac{x}{y} = x{:}y$$

Comments:

- The population and interval (or point) of time for which the data apply must be specified, just as for rates.

- Ratios can be calculated for rates just as for number of events.

- y <u>does</u> <u>not</u> <u>necessarily</u> define a "population at risk" as it does in the formula for incidence rates, attack rates, and mortality rates; and x is not necessarily a part of the population defined by y.

- Customarily, both the x and y values are divided by either the value of x or the value of y so that one number in the ratio is equal to 1.0. For example, if a group of 20 persons have a particular disease and 2 persons die from that disease, then the ratio of cases to deaths is more properly expressed not as 20:2, but, dividing both numbers by 2, as 10:1 (10 cases : 1 death). The interpretation is that in this episode there were ten cases for each death (or there were 10 times as many cases as deaths).

Example: In the previous example of the calculation of an attack rate, there were 19 males and 7 females. What was the ratio of male cases to female cases?

$$\text{Ratio of cases, Male : Female} = 19 : 7 = \frac{19}{7} : \frac{7}{7} = \underline{2.7:1}$$

EXAMPLES OF THE USE OF RATES AND RATIOS

EXAMPLE A - St. Louis encephalitis
(consists of Parts 1 through 5)

PART 1

Given: During 1966, a total of 126 cases of St. Louis encephalitis (SLE) was reported from a community having a population of 20,000.

Required: Calculate the incidence rate of SLE in the community during 1966.

Solution: The formula for calculating an incidence rate is $\frac{x}{y} \times k$. In this problem x represents the 126 cases of St. Louis encephalitis reported in 1966 and y represents the population at risk of the disease during 1966--the 20,000 people in the community.

Placing these values in the formula we have:

$$\text{Rate} = \frac{126}{20{,}000} \times k$$

Since a k value was not specified in the statement of what was required, several different ones will be used to illustrate their effect.

(1) $x = 126$
$y = 20{,}000$
$k = 1{,}000$

$$\text{Rate} = \frac{x}{y} \times k$$

$$\text{Rate} = \frac{126}{20{,}000} \times 1{,}000 = \frac{126}{20} = \underline{6.3 \text{ cases per } 1{,}000 \text{ population}}.$$

(2) If k is given a value of 10,000 the rate becomes:

$$\text{Rate} = \frac{x}{y} \times k$$

$$\text{Rate} = \frac{126}{20{,}000} \times 10{,}000 = \frac{126}{2} = \underline{63.0 \text{ cases per } 10{,}000 \text{ population}}$$

(3) If k is given a value of 100,000, the rate becomes:

$$\text{Rate} = \frac{x}{y} \times k$$

$$\text{Rate} = \frac{126}{20{,}000} \times 100{,}000 = 126 \times 5 = \underline{630.0 \text{ cases per } 100{,}000 \text{ population}}.$$

All three of the solutions shown are correct and acceptable. However, solution #1 might be somewhat preferable to the others since it provides the smallest whole number greater than one for an answer.

The interpretation of this rate is that during that year and in that city 6.3 persons in every 1,000 in the community acquired that illness. Alternatively, one could say that the risk of acquiring that illness in that community in that year was 6.3 per 1,000.

PART 2

Given: Of the 126 cases of SLE previously referred to, none occurred during the period January thru March, 5 occurred during the period April thru June, 113 occurred during July thru September, and 8 occurred during October thru December.

Required: (1) Calculate the incidence rates per 10,000 population for SLE for each of the quarterly periods.
(2) Calculate the proportional distribution of the cases by season.

Solution: (1) Incidence rates

a. 1st Quarter:

$x = 0$
$y = 20{,}000$
$k = 10{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{0}{20{,}000} \times 10{,}000 = \frac{0}{2} \times 1$$

$$= \underline{0.0 \text{ cases per } 10{,}000 \text{ population}}$$

(b) 2nd Quarter:

$x = 5$
$y = 20{,}000$
$k = 10{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{5}{20{,}000} \times 10{,}000 = \frac{5}{2} \times 1$$

= 2.5 cases per 10,000 population.

(c) 3rd Quarter:

$x = 113$
$y = 20{,}000$
$k = 10{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{113}{20{,}000} \times 10{,}000 = \frac{113}{2}$$

= 56.5 cases per 10,000 population.

(d) 4th Quarter:

$x = 8$
$y = 20{,}000$
$k = 10{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{8}{20{,}000} \times 10{,}000 = \frac{8}{2}$$

= 4.0 cases per 10,000 population.

(2) Proportional distribution

(a) 1st Quarter

$x = 0$ cases
$y = 126$ cases
$k = 100$

$$\% = \frac{x}{y} \times k = \frac{0}{126} \times 100 = 0\%$$

(b) 2nd Quarter

$x = 5$ cases
$y = 126$ cases
$k = 100$

$$\% = \frac{5}{126} \times 100 = 4.0\%$$

(c) 3rd Quarter

$x = 113$ cases
$y = 126$ cases
$k = 100$

$$\% = \frac{113}{126} \times 100 = 89.7\%$$

(d) 4th Quarter

$x = 8$ cases
$y = 126$ cases
$k = 100$

$$\% = \frac{8}{126} \times 100 = 6.3\%$$

All Quarters = 0.0 + 4.0 + 89.7 + 6.3 = 100.0%

The interpretations are as follows:
Quarterly rates: During the time specified, the risk of illness from SLE increased from zero in the first quarter to a maximum of 56.5/10,000 in the third quarter, and subsequently decreased to 4.0/10,000 in the fourth.
Proportional distribution: Of the cases which occurred during the year, 0.0% occurred in the first quarter, 4.0% in the second, 89.7% in the third, and 6.3% in the fourth.

Part 3

Where: Further investigation of the 126 cases of SLE revealed that 67 cases were males and the rest were females. The number of males in the community is 9,200.

Required:

(1) Calculate the sex-specific incidence rates per 10,000 population.
(2) Determine the ratio of male cases to female cases and the ratio of the male rate to the female rate.
(3) Calculate the proportional distribution of the cases by sex.

Solution:

(1) Sex-specific incidence rates

(a) Incidence rate in males:

x = 67
y = 9,200
k = 10,000

$$\text{Rate} = \frac{x}{y} \times k = \frac{67}{9{,}200} \times 10{,}000$$

$$= 0.00728 \times 10{,}000$$

$$= \underline{72.8 \text{ cases per } 10{,}000 \text{ males}}.$$

(b) Incidence rate in females:

x = 126-67 = 59
y = 20,000-9,200 = 10,800
k = 10,000

$$\text{Rate} = \frac{x}{y} \times k = \frac{59}{10{,}800} \times 10{,}000$$

$$= 0.00546 \times 10{,}000$$

$$= \underline{54.6 \text{ cases per } 10{,}000 \text{ females}}.$$

Note that the sex-specific rates cannot be added together to get the overall rate (which is 63.0/10,000).

(2) Ratios:

(a) Ratio of male to female cases:

x = males cases = 67
y = female cases = 59
k = 1

$$\text{Rate} = \frac{x}{y} \times k = \frac{67}{59} \times 1 = 67{:}59$$

Strictly speaking, the above ratio is correct as it stands, 67:59. However, in this form the ratio is difficult to meaningfully compare with sex ratios calculated for other places or other years. The solution to this difficulty is to divide both the 67 and 59 by either of these numbers so that one of them becomes 1.0 and the other becomes some multiple or fraction of 1:

$$\frac{67}{59} : \frac{59}{59} = 1.14 : 1$$

The interpretation of this ratio is that for every 1.14 male case reported there was one female case reported.

The above problem could also be solved by dividing both sides by the larger number 67:

$$\frac{67}{67} : \frac{59}{67} = 1 : 0.88$$

The interpretation of this ratio is that for every male case that was reported 0.88 female cases were reported.

Although both ratios are acceptable, the former 1.14 : 1, is preferred, since it does not contain a number smaller than 1.

(b) Ratio of male rate to female rate:

x = male rate = 72.8/10,000
y = female rate = 54.6/10,000

Ratio = male rate: female rate = 72.8: 54.6 = <u>1.33: 1</u>

The interpretation of this ratio is that the risk of acquiring this illness is 1.33 times greater in males than in females.

(3) Proportional distribution of the cases by sex:

(a) Males

x = 67 cases
y = 126 total cases
k = 100

$$\% = \frac{67}{126} \times 100 = \underline{53.2\%}$$

(b) Females

x = 59 cases
y = 126 cases
k = 100

$$\% = \frac{59}{126} \times 100 = \underline{46.8\%}$$

All cases = 53.2 + 46.8 = <u>100.0%</u>

PART 4

Given: Another item of information obtained from each case during the investigation was the age of the person who had the disease. This information was tabulated by age group and is presented below. Also given is the total number of people in each of these age groups who live in the community.

Age Group (years)	# of Cases	Population
0 – 9	17	3,400
10 – 19	18	4,200
20 – 29	9	2,800
30 – 39	11	2,600
40+	71	7,000
TOTAL	126	20,000

Required:

(1) Calculate the age-specific incidence rate per 1,000 population for each of the age groups shown in the table above.

(2) Calculate the proportional distribution of the cases by age-group

Solution:

(1) Age-specific incidence rates.

In calculating the age-specific incidence rates, x is equal to the number of ill persons (cases) in the specified age group, and y is equal to the total number of persons in that age group.

(a) 0 - 9 year age group:

$x = 17$
$y = 3,400$
$k = 1,000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{17}{3,400} \times 1,000 = 0.0050 \times 1,000$$

= 5.0 cases per 1,000 persons 0 - 9 years old.

(b) 10 - 19 year age group:

$x = 18$
$y = 4,200$
$k = 1,000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{18}{4,200} \times 1,000 = 0.0043 \times 1,000$$

= 4.3 cases per 1,000 persons 10 - 19 years old.

(c) 20 - 29 year age group:

$x = 9$
$y = 2,800$
$k = 1,000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{9}{2,800} \times 1,000 = 0.0032 \times 1,000$$

= 3.2 cases per 1,000 persons 20 - 29 years old.

(d) 30 - 39 year age group:

$x = 11$
$y = 2,600$
$k = 1,000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{11}{2,600} \times 1,000 = 0.0042 \times 1,000$$

= 4.2 cases per 1,000 persons 30 - 39 years old.

(e) 40 years and older age group:

$x = 71$
$y = 7,000$
$k = 1,000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{71}{7,000} \times 1,000 = 0.0101 \times 1,000$$

= 10.1 cases per 1,000 persons 40+ years old.

(2) Proportional distribution

(a) 0-9 year age group

$x = 17$ cases; $y = 126$ cases; $k = 100$

$$\% = \frac{17}{126} \times 100 = 13.5\%$$

(b) 10 - 19 year age group

$x = 18$ cases; $y = 126$ cases; $k = 100$

$$\% = \frac{18}{126} \times 100 = 14.3\%$$

(c) 20 - 29 year age group

$x = 9$ cases; $y = 126$ cases; $k = 100$

$$\% = \frac{9}{126} \times 100 = 7.1\%$$

(d) <u>30 - 39 year age group</u>

$x = 11$ cases; $y = 126$ cases; $k = 100$

$$\% = \frac{11}{126} \times 100 = \underline{8.7\%}$$

(e) <u>40 years and older age group</u>

$x = 71$ cases; $y = 126$ cases; $k = 100$

$$\% = \frac{71}{126} \times 100 = \underline{56.3\%}$$

ALL CASES = 13.5 + 14.3 + 7.1 + 8.7 + 56.3 = <u>99.9%</u>

PART 5

Given: Four of the 126 cases died. One was less than 9 years old and three were over 40 years old. Two were males and two were females.

Required: Calculate the following <u>mortality rates</u> per 100,000 population:

(1) Community-wide mortality rate.

(2) Age-specific mortality rates for the affected age groups.

(3) Sex-specific mortality rates.

Solution: (1) <u>Community-wide mortality rate</u>:

$x = 4$
$y = 20{,}000$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{4}{20{,}000} \times 100{,}000 = \frac{400{,}000}{20{,}000}$$

= <u>20 deaths per 100,000 population</u>.

(2) <u>Age-specific mortality rates</u>:

(a) 0 - 9 year age group

$x = 1$
$y = 3{,}400$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{1}{3{,}400} \times 100{,}000 = \frac{100{,}000}{3{,}400}$$

= <u>29.4 deaths per 100,000 population 0 - 9 years old</u>.

(b) 40+ age group:

$x = 3$
$y = 7{,}000$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{3}{7{,}000} \times 100{,}000 = \frac{300{,}000}{7{,}000}$$

= <u>42.9 deaths per 100,000 population 40+ years old</u>.

(3) <u>Sex-specific mortality rates</u>:

(a) Males:

$x = 2$
$y = 9{,}200$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{2}{9{,}200} \times 100{,}000 = \frac{200{,}000}{9{,}200}$$

= <u>21.7 deaths per 100,000 males</u>.

(b) Females:

$x = 2$
$y = 10{,}800$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{2}{10{,}800} \times 100{,}000 = \frac{200{,}000}{10{,}800}$$

= <u>18.5 deaths per 100,000 females</u>.

EXAMPLE B - Staphylococcal intoxication
(consists of Parts 1 through 4)

<u>PART 1</u>

Given: During the evening of July 4, a total of 17 persons were given emergency treatment at Suburban Community Hospital for a condition diagnosed as staphylococcal intoxication. Interviews with these persons lead to the identification of an additional 39 people who were ill with signs and symptoms compatible with staphylococcal intoxication but who did not seek medical attention. Further investigation revealed that all of the ill persons and 42 others who did not become ill had attended an all-day picnic on July 4.

Required: What is the attack rate of staphylococcal intoxication among the group that attended the picnic?

Solution: $x = 17 + 39 = \underline{56}$, the total number of ill persons.
$y = 17 + 39 + 42 = \underline{98}$, the total number of persons who were present, and therefore were "at risk" of acquiring the disease.

$k = \underline{100}$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{56}{98} \times 100 = 0.5714 \times 100$$

$$= \underline{57.1 \text{ cases per 100 persons attending} = 57.1\%}$$

In this instance since the k value is 100, the rate may also be expressed as a percentage, 57.1%.

PART 2

Given: 14 of the cases and 37 of the well persons were females.

Required: (1) Calculate the sex-specific attack rates.
(2) Calculate the ratio of the rate in males to the rate in females.

Solution: (1) Sex-specific attack rates:

(a) Females:

$x = \underline{14}$, the number of ill females
$y = 14 + 37 = \underline{51}$, the total number of females present
$k = \underline{100}$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{14}{51} \times 100 = 0.2745 \times 100$$

$$= \underline{27.5\% \text{ or, } 27.5 \text{ cases per 100 females present}}.$$

(b) Males:

$x = 56-14 = \underline{42}$, the number of ill males
$y = 98-(14 + 37) = 98-51 = \underline{47}$, the total number of males present
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{42}{47} \times 100 = 0.8936 \times 100$$

$$= \underline{89.4\% \text{ or, } 89.4 \text{ cases per 100 males present}}.$$

(2) Ratio of attack rates:

x = attack rate in males = 89.4%
y = attack rate in females = 27.5%
$k = 1$

Ratio of attack rate in males to that in females:

$$\text{Ratio} = 89.4:27.5 = \frac{89.4}{27.5} : \frac{27.5}{27.5} = \underline{3.3:1}$$

The interpretation of this ratio is that the attack rate in males is 3.3 times greater than that in females. Alternatively, one could say that the risk of illness was 3.3 times greater in males than in females.

PART 3

Given: The age group distribution of the ill and well persons is shown in the table below.

Age Group (years)	Number Ill	Number Well
0 – 9	0	13
10 – 19	2	14
20 – 29	17	10
30 – 39	24	4
40+	13	1
TOTAL	56	42

Required: Calculate the age-specific attack rates for each of the age groups shown in the table above.

Solution: In calculating the age-specific attack rates, x is equal to the number of ill persons in the specified age group, and y is equal to the total number of persons in that age group.

(1) 0 - 9 age group:

$x = 0$
$y = 0 + 13 = \underline{13}$
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{0}{13} \times 100 = 0 \times 100 = \underline{0.0\%}$$

(2) 10 - 19 age group;

$x = 2$
$y = 2 + 14 = 16$
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{2}{16} \times 100 = 0.1250 \times 100 = \underline{12.5\%}$$

(3) 20 - 29 age group;

$x = 17$
$y = 17 + 10 = 27$
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{17}{27} \times 100 = 0.6296 \times 100 = \underline{63.0\%}$$

(4) 30 - 39 age group:

$x = 24$
$y = 24 + 4 = 28$
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{24}{28} \times 100 = 0.8571 \times 100 = \underline{85.7\%}$$

(5) 40+ age group:

$x = 13$
$y = 13 + 1 = 14$
$k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{13}{14} \times 100 = 0.9286 \times 100 = \underline{92.9\%}$$

Part 4

Given: Upon questioning, 53 of the ill persons and 3 of the well persons could definitely remember that they had eaten potato salad that had been prepared at the home of one of the families attending the picnic. All other persons at the picnic denied having eaten any potato salad.

Required:
(1) Calculate the food-specific attack rate for those who ate potato salad.
(2) Calculate the attack rate among those persons who claimed not to have eaten any of the potato salad.

Solution:

(1) Persons who ate the salad

x = number of ill that ate potato salad = 53
y = total number that ate potato salad = 53 + 3 = 56
k = 100

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{53}{56} \times 100 = 0.9464 \times 100$$

= 94.6% (or, 94.6 cases per 100 population).

(2) Persons who did not eat the salad

x = number ill that did not eat any salad = 56 - 53 = 3
y = total number of persons that did not eat salad = 98 - (53 + 3) = 98 - 56 = 42
k = 100

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{3}{42} \times 100 = \frac{300}{42} = \underline{7.1\%}$$

EXAMPLE C - Rubeola
(consists of Parts 1 through 4)

PART 1

Given: During the week beginning October 28 and ending November 3, 12 cases of rubeola were reported to the city health department. Subsequent investigation has revealed that 9 of these cases reside in the same census tract and are all less than 10 years old. The population of the city is 50,000; the population of the census tract in which the 9 cases less than 10 years old reside is 5,000. There are 900 children in that census tract who are less than 10 years old, and an estimated 47 percent of them are immune either because of previous rubeola infection or because they have been vaccinated against rubeola.

Required: Calculate the incidence rate per 100,000 population for the following populations:

(1) The community.
(2) Nonimmune census tract residents less than 10 years old.

Solution:

(1) The community:

$x = 12$
$y = 50{,}000$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{12}{50{,}000} \times 100{,}000 = 12 \times 2$$

$= \underline{24.0 \text{ cases per } 100{,}000 \text{ population}}.$

(2) Nonimmune census tract residents less than 10 years old:

$x = 9$
$y = 900-(47\% \text{ of } 900) = 900-423 = 477$
$k = 100{,}000$

$$\text{Rate} = \frac{x}{y} \times k = \frac{9}{477} \times 100{,}000 = 9 \times 209.64$$

$= \underline{1886.8 \text{ cases per } 100{,}000 \text{ population}}.$

PART 2

Given: During the following six weeks an additional 214 cases of rubeola were identified through physician and school reports and through investigation of cases. The age-group distribution of the cases and the estimated total and susceptible populations are shown in the following table.

Age Group (years)	Number of Cases	Population	
		Total	Susceptible
0 – 4	169	4,200	2,310
5 – 9	49	5,150	1,700
10 – 14	7	4,800	530
15+	1	35,850	1,790
TOTAL	226	50,000	6,330

Required: Calculate, from the figures above, the attack rate per 1,000 susceptibles for each age group and for the total of susceptibles in all age groups.

Solution:

(1) 0 - 4 age group:

x = 169
y = 2,310
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{169}{2{,}310} \times 1000$$

= 73.2 cases per 1,000 susceptibles.

(2) 5 - 9 age group:

x = 49
y = 1,700
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{49}{1{,}700} \times 1{,}000$$

= 28.8 cases per 1,000 susceptibles.

(3) 10 - 14 age group:

x = 7
y = 530
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{7}{530} \times 1{,}000$$

= 13.2 cases per 1,000 susceptibles.

(4) 15+ age group:

x = 1
y = 1,790
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{1}{1{,}790} \times 1{,}000$$

= 0.56 cases per 1,000 susceptibles.

(5) All age groups:

$x = 226$
$y = 6,330$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{226}{6,330} \times 1,000$$

$= $ 35.7 cases per 1,000 susceptibles.

PART 3

Given: Of the rubeola cases, 109 are males, as are 24,300 of the total population and 3,150 of the susceptibles.

Required: (1) Calculate the sex-specific attack rates per 1,000 for the susceptible population.

(2) Calculate the ratio of the attack rate in susceptible males to the attack rate in the susceptible females.

Solution:

(1) Sex-specific rates:

(a) Males:

$x = 109$
$y = 3,150$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{109}{3,150} \times 1,000$$

$= $ 34.6 cases per 1,000 susceptibles.

(b) Females:

$x = 226-109 = 117$
$y = 6,330-3,150 = 3,180$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{117}{3,180} \times 1,000 = 117 \times 0.3145$$

$= $ 36.8 cases per 1,000 susceptible females.

(2) Ratio of rates (male : female) in susceptibles:

$x = \text{male} = 34.6/1,000$
$y = \text{female} = 36.8/1,000$

$$\text{Ratio} = x:y = 34.6:36.8 = \frac{34.6}{34.6} : \frac{36.8}{34.6} = 1:1.06$$

The interpretation of this ratio is that males and females are at an approximately equal risk of acquiring the illness.

Age Group (years)	Number of Cases	Population	
		Total	Susceptible
0 – 4	169	4,200	2,310
5 – 9	49	5,150	1,700
10 – 14	7	4,800	530
15+	1	35,850	1,790
TOTAL	226	50,000	6,330

Required: Calculate, from the figures above, the attack rate per 1,000 susceptibles for each age group and for the total of susceptibles in all age groups.

Solution:

(1) 0 - 4 age group:

x = 169
y = 2,310
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{169}{2{,}310} \times 1000$$

= 73.2 cases per 1,000 susceptibles.

(2) 5 - 9 age group:

x = 49
y = 1,700
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{49}{1{,}700} \times 1{,}000$$

= 28.8 cases per 1,000 susceptibles.

(3) 10 - 14 age group:

x = 7
y = 530
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{7}{530} \times 1{,}000$$

= 13.2 cases per 1,000 susceptibles.

(4) 15+ age group:

x = 1
y = 1,790
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{1}{1{,}790} \times 1{,}000$$

= 0.56 cases per 1,000 susceptibles.

(5) <u>All age groups</u>:

$x = 226$
$y = 6,330$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{226}{6,330} \times 1,000$$

$= \underline{35.7 \text{ cases per } 1,000 \text{ susceptibles}}.$

<u>PART 3</u>

Given: Of the rubeola cases, 109 are males, as are 24,300 of the total population and 3,150 of the susceptibles.

Required: (1) Calculate the sex-specific <u>attack rates</u> per 1,000 for the susceptible population.

(2) Calculate the <u>ratio</u> of the attack rate in susceptible males to the attack rate in the susceptible females.

Solution:

(1) <u>Sex-specific rates</u>:

(a) Males:

$x = 109$
$y = 3,150$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{109}{3,150} \times 1,000$$

$= \underline{34.6 \text{ cases per } 1,000 \text{ susceptibles}}.$

(b) Females:

$x = 226-109 = 117$
$y = 6,330-3,150 = 3,180$
$k = 1,000$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{117}{3,180} \times 1,000 = 117 \times 0.3145$$

$= \underline{36.8 \text{ cases per } 1,000 \text{ susceptible females}}.$

(2) <u>Ratio of rates (male : female) in susceptibles</u>:

$x = \text{male} = 34.6/1,000$
$y = \text{female} = 36.8/1,000$

$$\text{Ratio} = x:y = 34.6:36.8 = \frac{34.6}{34.6} : \frac{36.8}{34.6} = \underline{1:1.06}$$

The interpretation of this ratio is that males and females are at an approximately equal risk of acquiring the illness.

PART 4

Given: During the outbreak, the usefulness of vaccine in preventing rubeola was questioned because several of the cases were known to have been immunized previously. Evaluation of the case history forms disclosed that 14 of the cases under 10 years of age had in fact been immunized at least one month prior to having acquired the disease. Of the nonsusceptibles, 74 percent had no history of having had rubeola, but had been vaccinated.

Required: Calculate the efficacy of the vaccine in persons less than 10 years old. (You will need to refer to the table in Part 2 for various data.)

Solution: The formula for calculating vaccine efficacy is:

$$\text{Efficacy} = \frac{u-v}{u} \times 100$$

u = Attack rate in unvaccinated persons
v = Attack rate in vaccinated persons

(a) Calculation of u:

x = number of unvaccinated cases = (169 + 49) - 14 = 218-14 = 204
y = number of unvaccinated persons = 2,310 + 1,700 = 4,010
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{204}{4,010} \times 1,000 = 204 \times 0.2494$$

= 50.9 cases per 1,000 unvaccinated susceptibles.

(b) Calculation of v:

x = number of vaccinated cases = 14
y = number of vaccinated persons = 74% of [(4,200-2,310) + (5,150-1,700)] = 0.74 X 5,340 = 3,952
k = 1,000

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{14}{3,952} \times 1,000 = 14 \times 0.2530$$

= 3.5 cases per 1,000 vaccinated population.

(c) Calculation of vaccine efficacy in persons under 10 years old:

$$\text{Efficacy} = \frac{u-v}{u} \times 100 = \frac{50.9 - 3.5}{50.9} \times 100$$

$$= \frac{47.4}{50.9} \times 100 = 0.931 \times 100$$

= 93.1%

EXAMPLE D - Nosocomial Staphylococcus aureus infections
(Consists of parts 1 through 5)

PART 1

Given: During a recent 34-month period there were a total of 158 admissions to the burn-trauma unit of a hospital, with 52 of the persons admitted subsequently experiencing an infection of the burn wound or skin graft site with Staphylococcus aureus.

Required: Calculate the attack rate of wound infections in this population due to Staphylococcus aureus.

Solution:

x = 52 cases
y = 158 admissions (persons at risk)
k = 100

$$\text{Attack rate} = \frac{x}{y} \times = \frac{52}{158} \times 100 = \underline{32.9 \text{ cases per 100 admissions}}$$

PART 2

Given: For a comparable period before this 34-month period the attack rate in the same unit was 6.1 cases of Staphylococcus aureus wound infections per 100 admissions.

Required: Calculate the ratio of the attack rates for the two periods and interpret the result.

Solution:

Ratio = (Rate during most recent period) : (Rate during previous period)
= 32.9 : 6.1 = 5.4 : 1

The interpretation of this ratio is that the risk of Staphylococcus aureus wound infection among persons admitted to the burn-trauma unit was 5.4 times greater during the most recent period than during the previous period.

PART 3

Given: Forty-nine of the cases, and 129 of the persons admitted, were admitted with burns. The others admitted had some other type of trauma.

Required: (1) Calculate the attack rate among persons admitted with burns.

(2) Calculate the attack rate among persons admitted to the unit with trauma other than burns.

(3) Calculate and interpret the ratio between these two rates.

Solution: (1) Attack rate of Staphylococcus aureus wound infections in burn patients:

$x = 49;\ y = 129;\ k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{49}{129} \times 100 = \underline{38.0 \text{ cases per 100 admissions}}$$

(2) Attack rate of Staphylococcus aureus wound infections in other patients in the same unit:

$x = 52 - 49 = 3;\ y = 158 - 129 = 29;\ k = 100$

$$\text{Attack rate} = \frac{x}{y} \times k = \frac{3}{29} \times 100 = \underline{10.3 \text{ cases per 100 admissions}}$$

(3) Ratio (burned : others) = 38.0 : 10.3 = 3.7 : 1

The interpretation of this ratio is that the risk of Staphylococcus aureus wound infection among burn patients is 3.7 times greater than persons admitted to the same unit for reasons other than burn treatment.

PART 4

Given: Eighty-one of those admitted to the unit, and 16 of the cases, had burns that covered less than 20% of their body. All other cases had burns covering 20% or more of their body.

Required: (1) Calculate the Staphylococcus aureus wound infection rate according to the percent of body area burned.

(2) Compare the two rates by calculating and interpreting the ratio of the greater rate to the lesser rate.

Solution: (1) Rate by percent of body area:

(a) Infection rate among persons burned less than 20%:

$x = 16;\ y = 81;\ k = 100$

$$\text{Rate} = \frac{x}{y} \times k = \frac{16}{81} \times 100 = \underline{19.8 \text{ infections per 100 admissions}}$$

(b) Infection rate among persons burned 20% or more:

$x = 49 - 16 = 33;\ y = 129 - 81 = 48;\ k = 100$

$$\text{Rate} = \frac{x}{y} \times k = \frac{33}{48} \times 100 = \underline{68.8 \text{ infections per 100 admissions}}$$

(2) Ratio of rates:
(rate in 20+% : rate in less than 20%) = 68.8 ; 19.8 = 3.5 : 1.
Interpretation: Persons having burns covering 20% or more of their body have a risk of Staphylococcus aureus wound infection 3.5 times greater than persons less extensively burned.

PART 5

Given: The risk of S. aureus wound infection among burn patients was also assessed as a function of the length of time the patients were exposed to the hospital environment, as measured by their length of stay. A review of the medical records of each person admitted to the burn-trauma unit for burn treatment produced the following information:

Length of stay (days)	Number of Persons	Number of Person-days of Exposure	Number of persons Developing *S. aureus* Wound Infection
14 or less	82	676	11
15+	47	1,457	38
TOTAL	129	2,133	49

Required: (1) Calculate the infections rate per 100 person-days of exposure (i.e., per 100 patient-days) for (a) all persons, regardless of their length of stay; and (b) separately for each of the two lengths of stay identified in the table: two weeks or less, and greater than two weeks.

(2) Calculate and interpret the ratio of the rates obtained in (b).

Solution:

(1) Infections rates:

(a) All persons

$$\text{Infections rate} = \frac{\text{Number of cases}}{\text{Population at risk}} \times 100$$
$$= \frac{49 \text{ cases} \times 100}{2133 \text{ patient-days}}$$
$$= \underline{2.3 \text{ infections per 100 patient-days of exposure}}$$

(b) By length of stay

1. Two weeks or less

$$\text{Infections rate} = \frac{11}{676} \times 100 = \frac{1100}{676}$$
$$= \underline{1.6 \text{ infections per 100 patient-days of exposure}}$$

2. More than two weeks

$$\text{Infections rate} = \frac{38}{1{,}457} \times 100 = \frac{3{,}800}{1{,}457} \times 100$$
$$= \underline{2.6 \text{ infections per 100 patient-days of exposure}}$$

(2) Ratio (Greater than 2 weeks : 2 weeks or less) = 2.6 : 1.6 = 1.6 : 1

Interpretation: The risk of acquiring a *S. aureus* burn wound infection by persons hospitalized longer than two weeks is 1.6 times greater than among persons hospitalized two weeks or less.

Practice Exercises

Now that you are familiar with the definitions and formulas for the five statistical measures presented in the text, you should be able to work the following practice exercises. As you solve each exercise, compare your answer to the answer listed on pages 30 and 31.

If you don't get that answer the first time, review the portions of the discussion and examples that deal with the kind of statistical measure that gives you difficulty.

EXERCISE A - Rates and Proportional Distributions

Part 1

Given: During 1972, 29 cases of tularemia occurred in a county with a population of 7,000 persons.

Required: Calculate the incidence of tularemia per 100,000 persons in that county during that year.

Part 2

Given: The distribution of the tularemia during the calendar year was: first quarter, 7; second quarter, 2; third quarter, 5; and the fourth quarter, 15.

Required: (1) Calculate the quarterly incidence rate per 10,000 population for each of the four quarters.

(2) Calculate the proportional distribution of the cases according to the calendar quarter in which they occurred.

Part 3

Given: 19 of the tularemia cases and 3,100 of the population are males.

Required: Calculate the sex-specific incidence rates per 100,000 population for that year.

Part 4

Given: 7 cases and 256 of the population, were in the 15 - 19 age group; 17 cases and 791 of the population were in the 20 - 29 age group; and the other cases were in the 30 - 39 age group, which had a population of 1,201.

Required:
(1) Calculate the age-specific attack rates per 1000 persons for these three age groups and the total of all three groups.
(2) Calculate the proportional distribution of the cases by age group.

EXERCISE B - Incidence Rates and Attack Rates

Part 1 Calculate the following incidence rates per 100,000 persons:

(1) 411 new cases of viral hepatitis during 1972 in a city of 975,000.

(2) 112 new cases of shigellosis in 1970 in a state having a population of 2.1 million.

(3) 29 new cases of primary and secondary syphilis in a 4-week period in a county of 179,000.

(4) 7 reported cases of aseptic meningitis during the second quarter of a year in a city's lower socioeconomic area, which had a population of 17,000 persons.

(5) 70,000 reported cases of measles during 1971 in a country of 200,000,000 persons.

Part 2 Calculate the following attack rates per 100 persons for a common source outbreak of salmonellosis which lasted 2 days:

(1) 37 ill persons in a group of 96 present at a picnic.

(2) 16 ill males out of a total of 43 males present.

(3) 21 ill females out of a total of 53 females present.

(4) 31 ill persons over 60 years of age out of a total of 59 persons present in that age group.

(5) 6 ill persons in the 30 - 39 age group out of 34 persons present in that age group.

EXERCISE C - Mortality Rates

Part 1

Given: During the calendar year of 1971 a total of 171 deaths was caused by influenza in a city of 450,000 persons. The temporal distribution of these deaths was as follows: first quarter, 54; second quarter, 43; third quarter, 35; and fourth quarter, 39.

Required: Calculate the annual and quarterly mortality rates per 100,000 population.

Part 2

Given: The age-group distributions of the 171 deaths and of the total population are shown in the following table.

Required: Calculate the mortality rate per 100,000 population for each age-group.

Age Group (years)	Number of deaths	Population
< 1	6	9,450
1 – 19	8	160,650
20 – 39	21	118,800
40 – 59	35	96,750
60+	101	64,350
TOTAL	171	450,000

EXERCISE D - Ratios

Part 1 Calculate the ratios specified, using the preferred methods (i.e., the smallest number in the ratio is 1):

(1) death-to-case ratios:

(a) 37 cases of yellow fever, 17 of which died.
(b) 114 cases of brucellosis, 1 of which died.
(c) 19 cases of cholera, 2 of which died.

(2) male-to-female case ratios:

(a) 49 male and 43 female cases of syphilis.
(b) 126 female and 201 male cases of gonorrhea.
(c) 14 female cases and 29 male cases of hepatitis-B in the 15 - 24 year age group.

(3) Age-group ratios, using age-specific incidence rates per 10,000 population:

(a) Hepatitis: 10 - 14 years = 14.1; and 25 - 29 years = 37.6.
(b) Measles encephalitis: less than 2 years old = 9.3; 2 - 5 years = 2.1.
(c) Tetanus: 15 - 39 years = 2.0; 60+ = 14.1
(d) Rubella: 1 - 4 years = 27.6; 5 - 9 years = 11.3.

Answers to practice exercises

Exercise A

Part 1. 414.3 cases per 100,000 population.

Part 2.

Quarter	a. Rate (cases per 10,000 population)	b. Percent Distribution
1st	10.0	24.1
2nd	2.9	6.9
3rd	7.1	17.2
4th	21.4	51.7

Part 3. Males: 612.9 cases per 100,000 males.
Females: 256.4 cases per 100,000 females

Part 4.

Age Group (years)	a. Rate (cases per 1,000 population	b. Percent Distribution
15 – 19	27.3	24.1
20 – 29	21.5	58.6
30 – 39	4.2	17.2
15 – 39	12.9	99.9

Exercise B

Part 1
(1) 42.2 cases per 100,000 population.
(2) 5.3 cases per 100,000 population
(3) 16.2 cases per 100,000 population.
(4) 41.2 cases per 100,000 population
(5) 35.0 cases per 100,000 population

Part 2
(1) 38.5 cases per 100 persons (38.5%)
(2) 37.2 cases per 100 males (37.2%)
(3) 39.6 cases per 100 females (39.6%)
(4) 52.5 cases per 100 persons over 60 years of age (52.5%)
(5) 17.6 cases per 100 persons 30 - 39 years old (17.6%)

Exercise C

Part 1 Annual: 38.0 deaths per 100,000 population.
First Quarter: 12.0 deaths per 100,000 population
Second Quarter: 9.6 deaths per 100,000 population
Third Quarter: 7.8 deaths per 100,000 population
Fourth Quarter: 8.7 deaths per 100,000 population

Part 2 Age group under 1 year: 63.5 cases per 100,000 population.
Age group 1 - 19: 5.0 cases per 100,000 population
Age group 20 - 39: 17.7 cases per 100,000 population.
Age group 40 - 59: 36.2 cases per 100,000 population.
Age group 60 and older: 157.0 cases per 100,000 population.

Exercise D

Part 1 (1) (a) Yellow fever = 1:2.18 (1 death per 2.18 cases).
(b) Brucellosis = 1:114 (1 death per 114 cases).
(c) Cholera = 1:9.50 (1 death per 9.5 cases).

(2) (a) Male-to-female ratio of syphilis cases = 1.14:1.
(b) Male-to-female ratio of gonorrhea cases = 1.60:1.
(c) Male-to-female ratio of hepatitis-B cases among persons 15 - 24 years of age = 2.07:1

(3) (a) Ratio of the hepatitis incidence rate in 10 - 14 year olds to that of the 25 - 29 year olds = 1:2.67.
(b) Ratio of the measles encephalitis incidence rate in those less than 2 years old to that of the 2 - 5 age group = 4.43:1.
(c) Ratio of the tetanus incidence rate in 15 - 39 year olds to that of the age group 60 and older = 1:7.05.
(d) Ratio of the rubella incidence rate in 1 - 4 year olds to that of the 5 - 9 year olds = 2.44:1.

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